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Pittsburgh Conference issue: more to see, hear, do at P-Con

Combine x ray and IR to assure paints with correct pigment values

Trendsurvey: uses of analytical instruments and equipment—1984

Instruments and technology for analytical chemistry

News of importance to people who work in research, development

Research & Development

SERVING THE $186-BILLION WORLDWIDE R&D INDUSTRY

Quality assurance of pigments for protective coatings. **See p 124.**

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ABOUT THE COVER

In the protective coating industry, pigments often are supplied as pastes based on a vehicle that is compatible with the base polymer used. The amount of pigment present in the pastes is an important indication of both the protective capability and the hiding power (opacity) of an applied coating.

Today, the quality control of paints and coatings involves the spectroscopic examination for pigment content. A related article begins on p 124.

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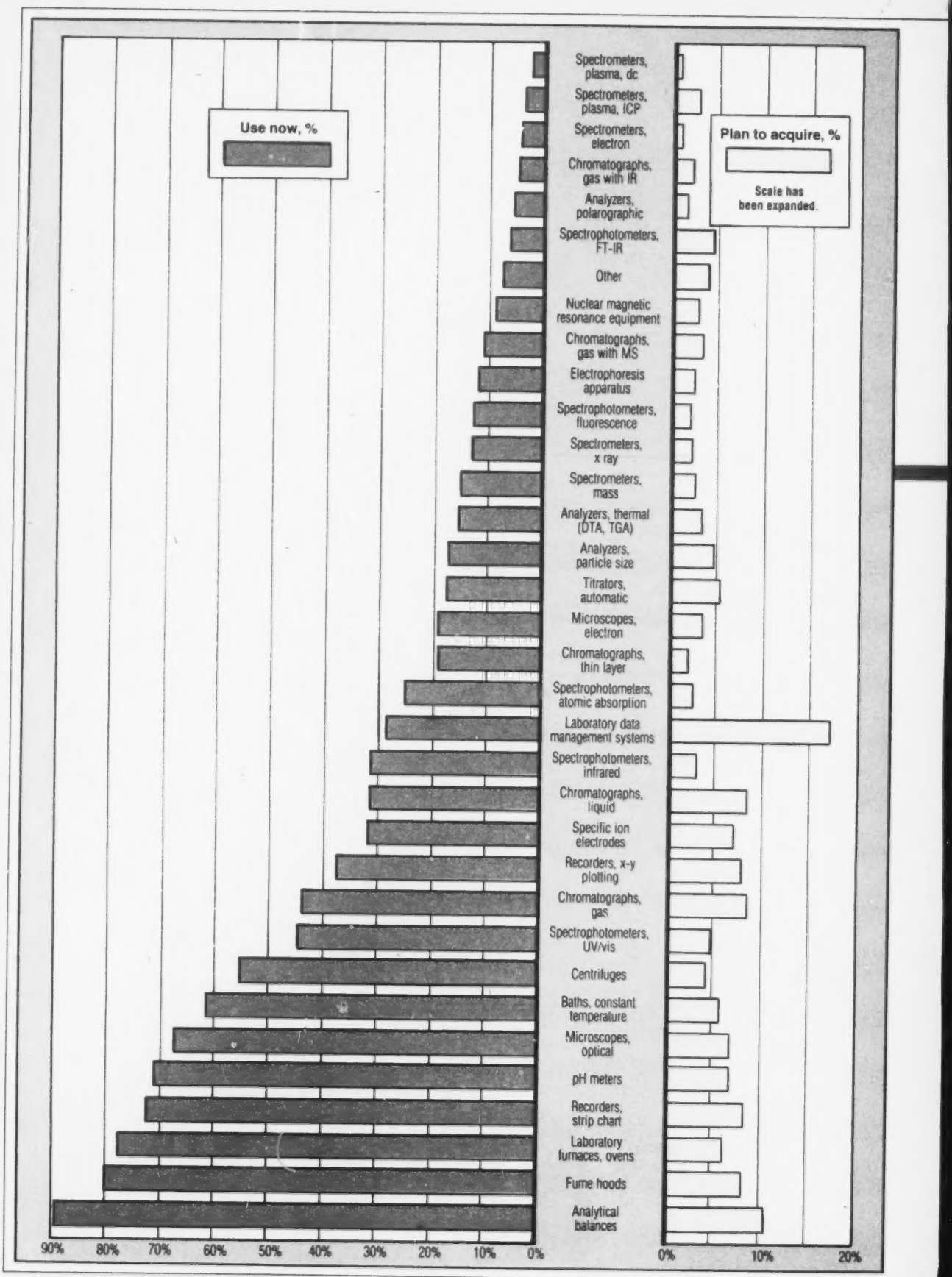

Use now, %
Plan to acquire, %
Scale has been expanded.
Spectrometers, plasma, dc
Spectrometers, plasma, ICP
Spectrometers, electron
Chromatographs, gas with IR
Analyzers, polarographic
Spectrophotometers, FT-IR
Other
Nuclear magnetic resonance equipment
Chromatographs, gas with MS
Electrophoresis apparatus
Spectrophotometers, fluorescence
Spectrometers, x ray
Spectrometers, mass
Analyzers, thermal (DTA, TGA)
Analyzers, particle size
Titrators, automatic
Microscopes, electron
Chromatographs, thin layer
Spectrophotometers, atomic absorption
Laboratory data management systems
Spectrophotometers, infrared
Chromatographs, liquid
Specific ion electrodes
Recorders, x-y plotting
Chromatographs, gas
Spectrophotometers, UV/vis
Centrifuges
Baths, constant temperature
Microscopes, optical
pH meters
Recorders, strip chart
Laboratory furnaces, ovens
Fume hoods
Analytical balances
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0%
10%
20%

TRENDSURVEY

Uses of analytical instruments and equipment, 1984

Planned acquisitions of newer types of instruments and equipment raise the index from last year, but after normalization for demographic changes, plans to acquire older types stay just about the same.

C.J. Mosbacher
Executive editor

WILL SCIENTISTS and engineers add more analytical instruments and equipment to their laboratories this year than in 1983? If you consider the raw data—that average present use dropped from 32.5 to 31.7% of respondents while plans to acquire rose from 4.6 to 4.97%—your answer would have to be yes. That would be reinforced by a drop in those with no plans to acquire within one year, from 47.7% of respondents in 1983 to 41.0% this year. But you could be wrong because of several other factors.

The largest factor is the dropping of three categories—automated wet chemistry analyzers, oxygen analyzers, and microchemical apparatus—that appeared last year, and their replacement by three new categories—gas chromatographs with IR, FT-IR spectrophotometers, and laboratory data management systems. The three old categories averaged 13.8% in present use and 2.17% in plans to acquire. Their elimination raises average present use for last year to 34.39% and average plans to acquire to 4.85% for the 30 categories left.

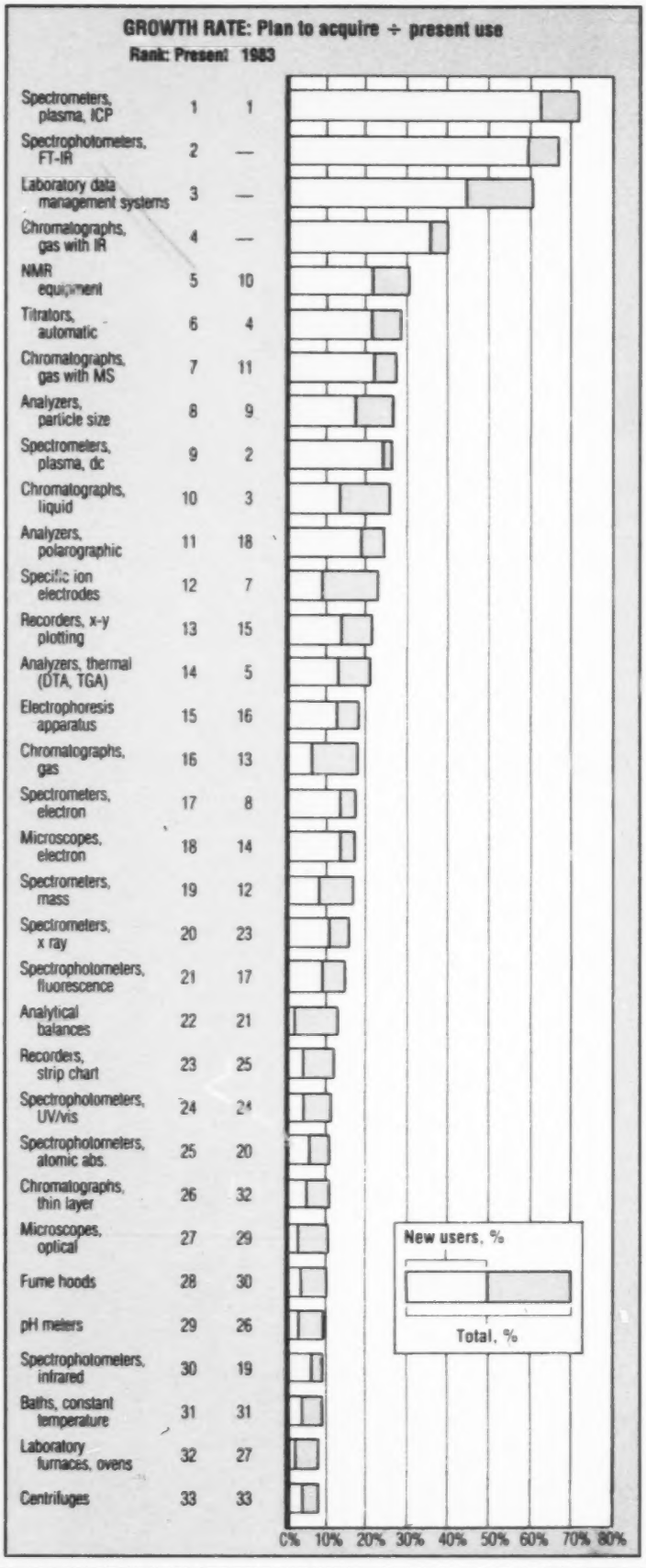
This year, the 13.5% average present use of the three new categories decreases the total average for all 33 categories in this year's Trendsurvey, while their average plans to acquire of just under 8% raises the total average. Eliminating the new categories and using the 30 that are the same as in 1983, one finds an average present use of 33.47% and average plans to acquire of 4.66%. Now, plans to acquire drop instead of rising for 1984.

But that still does not account for changes in demographics for this year's respondents compared to last year's. Engineering claimed 15% more, 23.3% compared to 20.2% last year. Life science and medicine also rose, from 19.0% to 20.2%, while representation of physical science dropped from 58.6% to 53.6%. By employer, industry and government representation dropped slightly while all other sectors rose. And by job function, representation of mangement categories rose while that of professional staff and other unspecified categories dropped.

A normalization procedure was applied to account for all of these demographic changes. For the 30 unchanged categories, this normalization gave an average present use of 33.86%—just 0.53 points, or 1.55%, less than last year's comparable figure. Average plans to acquire rose to 4.75%—0.10 points, or 2.06%, lower than last year.

It should be pointed out that changes in data for use and plans from year to year can affect the results of normalization. For example, for the 30 categories used here, plans to acquire this year for engineering averaged 4.46% compared to 4.28% last year; those for physical science were 5.00% compared to 5.21%. This tends to minimize the shift to engineering in the normalization procedure used. That plans to acquire in the life science and medical sector also rose, from 4.29 to 4.75%, also affects the normalization results. But the changes in plans to acquire are real, and the results of normalization do provide a valid comparison of the unchanged categories.

To add another perspective, of the 30 categories that are the same, 21 show de-


GROWTH RATE: Plan to acquire ÷ present use
Rank: Present 1983
Spectrometers, plasma, ICP 1 1
Spectrophotometers, FT-IR 2 —
Laboratory data management systems 3 —
Chromatographs, gas with IR 4 —
NMR equipment 5 10
Titrators, automatic 6 4
Chromatographs, gas with MS 7 11
Analyzers, particle size 8 9
Spectrometers, plasma, dc 9 2
Chromatographs, liquid 10 3
Analyzers, polarographic 11 18
Specific ion electrodes 12 7
Recorders, x-y plotting 13 15
Analyzers, thermal (DTA, TGA) 14 5
Electrophoresis apparatus 15 16
Chromatographs, gas 16 13
Spectrometers, electron 17 8
Microscopes, electron 18 14
Spectrometers, mass 19 12
Spectrometers, x ray 20 23
Spectrophotometers, fluorescence 21 17
Analytical balances 22 21
Recorders, strip chart 23 25
Spectrophotometers, UV/vis 24 24
Spectrophotometers, atomic abs. 25 20
Chromatographs, thin layer 26 32
Microscopes, optical 27 29
Fume hoods 28 30
pH meters 29 26
Spectrophotometers, infrared 30 19
Baths, constant temperature 31 31
Laboratory furnaces, ovens 32 27
Centrifuges 33 33
New users, %
Total, %
0% 10% 20% 30% 40% 50% 60% 70% 80%

creased present use, 9 increased. Plans to acquire are down in 15 categories, equal in 2, and up in 13, without demographic adjustments. Biggest losers in present use are UV/vis spectrophotometers, infrared spectrophotometers (but with the new FT-IR category, the total for IR is higher), atomic absorption spectrophotometers, GC, polarographic analyzers, and LC. In plans to acquire, LC is the biggest loser, followed by laboratory furnaces and ovens, IR spectrophotometers, automatic titrators, and GC.

Largest gain in present use is in optical microscopes, followed by electron microscopes, mass spectrometers, particle-size analyzers, and electron spectrometers. In plans to acquire, the largest gain is in x-y plotting recorders, followed by strip-chart recorders, particle-size analyzers, GC-MS, constant temperature baths, and optical microscopes.

Ranking by present use is shown in the first bar chart for all 33 categories and "other." On the same total-sample basis, rankings for plans to acquire are lead by the new category, laboratory data management systems, followed by analytical balances, strip-chart recorders, LC, GC, and fume hoods. Rankings by growth rate (plans divided by present use for each category) are shown in the second bar chart. Once again, ICP spectrometers lead the list, followed by the three new categories. The missing 6th ranking from 1983 is automated wet chemical analyzers.

Geographic distribution of respondents again parallels R&D circulation, lending validity to the results, with 6.1% New England, 17.4% Middle Atlantic, 17.9% East North Central, 5.7% West North Central, 13.5% South Atlantic, 2.8% East South Central, 7.1% West South Central, 4.4% Mountain, and 13.3% Pacific. No answer was provided by 11.8% of respondents.

By employer, 57.7% work in industry, 16.0% in universities, 15.5% in government, 3.8% in nonprofit organizations, 2.3% in medical research centers, 3.3% other, and 1.3% gave no answer. Corresponding data for 1983 were 60.3%, 14.7%, 15.8%, 3.1%, 2.0%, 3.0% and 1.1%.

By job function, 4.2% are corporate officers, 7.7% R&D executives, 15.8% project managers, 66.5% professional staff, 4.3% other, and 1.6% no answer. For 1983, the numbers were 3.4%, 6.7%, 13.7%, 69.0%, 5.5%, and 1.7%.

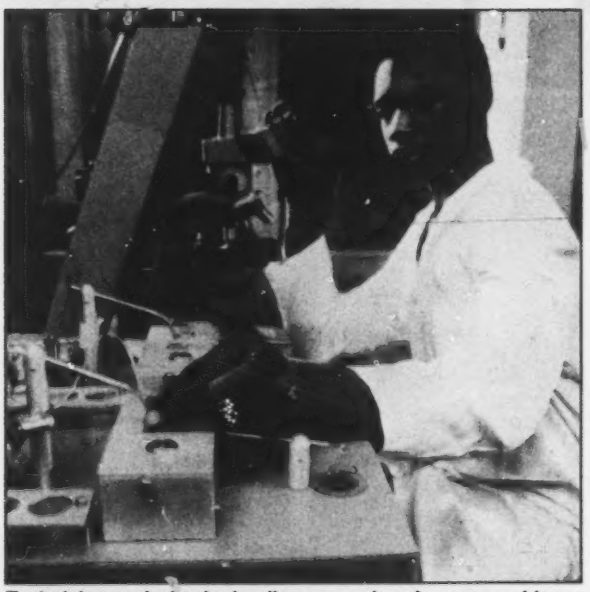
This Trendsurvey was conducted by including a prepaid business reply card in a mailing to R&D readers in the United States in late September 1983. To meet deadlines, only replies received by early November could be included. **R&D**

Growth rate (bar chart at left) is calculated with present use as base for each instrument category. Total includes all those who plan to acquire; new users are those who do not presently use that particular instrument but who plan to acquire. Difference is present users planning to acquire additional or replacement items.

PRESENT AND PLANNED USE: Data from 1,730 respondents * = 1983	Use now								Plan to acquire within 1 year								Growth rate = plan to acquire + by present use				
	Total 1,730		Engineering 403		Physical science 926		Life science or medicine 350		Total 1,730		Engineering 403		Physical science 926		Life science or medicine 350		Total	Present users who plan to acquire		New users	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	%	No.	%	No.	%
Analytical balances	1,530	88.4 *89.5	300	74.4	860	92.7	325	92.9	184	10.6 *11.1	32	7.9	107	11.5	39	11.1	12.0	162	10.6	22	1.4
Analyzers, particle size	309	17.9 *16.8	81	20.1	181	19.5	32	9.1	83	4.8 * 4.0	23	5.7	51	5.5	6	1.7	26.9	29	9.4	54	17.5
Analyzers, polarographic	103	6.0 * 9.0	15	3.7	70	7.5	17	4.9	25	1.4 * 1.3	5	1.2	16	1.7	4	1.1	24.3	5	4.9	20	19.4
Analyzers, thermal (DTA, TGA)	275	15.9 *15.6	66	16.4	182	19.6	16	4.6	57	3.3 * 3.9	11	2.7	39	4.2	6	1.7	20.7	21	7.6	36	13.1
Baths, constant temperature	1,064	61.5 *61.4	183	45.4	568	61.2	284	81.1	101	5.8 * 5.2	20	5.0	53	5.7	27	7.7	9.5	60	5.6	41	3.9
Centrifuges	953	55.1 *57.3	106	26.3	521	56.1	303	86.6	76	4.4 * 4.4	13	3.2	32	3.4	30	8.6	8.0	46	4.8	30	3.1
Chromatographs, gas	760	43.9 *47.1	100	24.8	499	53.8	135	38.6	142	8.2 * 9.4	20	5.0	104	11.2	13	3.7	18.7	95	12.5	47	6.2
Chromatographs, gas with IR	85	4.9 —	24	6.0	49	5.3	9	2.6	34	2.0 —	6	1.5	22	2.4	6	1.7	40.0	3	3.5	31	36.5
Chromatographs, gas with MS	204	11.8 *11.1	18	4.5	147	15.8	33	9.4	56	3.2 * 2.5	8	2.0	37	4.0	11	3.1	27.5	12	5.9	44	21.6
Chromatographs, liquid	547	31.6 *34.2	39	9.7	341	36.7	156	44.6	144	8.3 *10.5	10	2.5	92	9.9	40	11.4	26.3	72	13.2	72	13.2
Chromatographs, thin layer	341	19.7 *21.3	15	3.7	191	20.6	128	36.6	36	2.1 * 1.8	3	0.7	14	1.5	18	5.1	10.6	19	5.6	17	5.0
Electrophoresis apparatus	217	12.5 *12.2	11	2.7	56	6.0	148	42.3	41	2.4 * 2.1	5	1.2	11	1.2	25	7.1	18.9	13	6.0	28	12.9
Fume hoods	1,387	80.2 *81.5	277	68.7	787	84.8	281	80.3	141	8.2 * 7.7	45	11.2	66	7.1	26	7.4	10.2	100	7.2	41	3.0
Laboratory data mngmt. systems	492	28.4 —	112	27.8	261	28.1	111	31.7	299	17.3 —	63	15.6	163	17.6	67	19.1	60.8	82	16.7	217	44.1
Laboratory furnaces, ovens	1,319	76.2 *78.0	301	74.7	747	80.5	232	66.3	105	6.1 * 8.1	38	9.4	57	6.1	8	2.3	8.0	89	6.7	16	1.2
Microscopes, electron	340	19.7 *17.4	94	23.3	177	19.1	58	16.6	62	3.6 * 3.1	31	7.7	24	2.6	7	2.0	18.2	17	5.0	45	13.2
Microscopes, optical	1,177	68.0 *64.1	287	71.2	602	64.9	256	73.1	121	7.0 * 6.4	42	10.4	45	4.8	30	8.6	10.3	92	7.8	29	2.5
Nuclear magnetic resonance equipment	165	9.5 *11.8	11	2.7	122	13.1	28	8.0	51	2.9 * 2.8	9	2.2	31	3.3	9	2.6	30.9	16	9.7	35	21.2
pH meters	1,236	71.4 *72.7	206	51.1	683	73.6	311	88.9	121	7.0 * 7.7	28	6.9	57	6.1	33	9.4	9.8	94	7.6	27	2.2
Recorders, strip chart	1,254	72.5 *73.3	292	72.5	694	74.8	237	67.7	148	8.6 * 7.7	51	12.7	73	7.9	20	5.7	11.8	102	8.1	46	3.7
Recorders, x-y plotting	653	37.7 *38.5	194	48.1	355	38.3	86	24.6	137	7.9 * 6.7	49	12.2	60	6.5	28	8.0	21.0	50	7.7	87	13.3
Specific ion electrodes	553	32.0 *33.1	84	20.8	358	38.6	99	28.3	126	7.3 * 7.8	24	6.0	78	8.4	23	6.6	22.8	75	13.6	51	9.2
Spectrometers, electron	76	4.4 * 3.4	24	6.0	45	4.8	6	1.7	14	0.8 * 0.8	6	1.5	6	0.6	2	0.6	18.4	4	5.3	10	13.2
Spectrometers, mass	271	15.7 *14.4	51	12.7	176	19.0	37	10.6	45	2.6 * 3.2	11	2.7	27	2.9	6	1.7	16.6	22	8.1	23	8.5
Spectrometers, plasma, dc	41	2.4 * 2.6	5	1.2	31	3.3	2	0.6	11	0.6 * 0.9	3	0.7	7	0.8	1	0.3	26.8	1	2.4	10	24.4
Spectrometers, plasma, ICP	64	3.7 * 4.3	6	1.5	51	5.5	5	1.4	46	2.7 * 3.1	4	1.0	40	4.3	2	0.6	71.9	6	9.4	40	62.5
Spectrometers, x ray	235	13.6 *14.1	51	12.7	167	18.0	12	3.4	37	2.1 * 1.7	7	1.7	27	2.9	1	0.3	15.7	13	5.5	24	10.2
Spectrophotometers, atomic abs.	437	25.3 *29.1	35	8.7	319	34.4	70	20.0	47	2.7 * 3.7	5	1.2	30	3.2	12	3.4	10.8	21	4.8	26	5.9
Spectrophotometers, fluorescence	233	13.5 *15.0	22	5.5	115	12.4	91	26.0	34	2.0 * 2.2	2	0.5	13	1.4	17	4.9	14.6	12	5.2	22	9.4
Spectrophotometers, FT-IR	122	7.1 —	19	4.7	83	8.9	14	4.0	82	4.7 —	14	3.5	51	5.5	15	4.3	67.2	10	8.2	72	59.0
Spectrophotometers, infrared	545	31.5 *35.6	65	16.1	393	42.3	70	20.0	53	3.1 * 4.7	6	1.5	37	4.0	9	2.6	9.7	18	3.3	35	6.4
Spectrophotometers, UV/vis	770	44.5 *48.9	69	17.1	470	50.6	214	61.1	85	4.9 * 6.0	12	3.0	39	4.2	32	9.1	11.0	54	7.0	31	4.0
Titrators, automatic	312	18.0 *18.2	37	9.2	211	22.7	55	15.7	91	5.3 * 4.7	16	4.0	60	6.5	12	3.4	29.2	25	8.0	66	21.2
Other	141	8.2 * 9.9	39	9.7	65	7.0	33	9.4	66	3.8 * 4.2	14	3.5	36	3.9	15	4.3	46.8	31	22.0	35	24.8

Survey shows high R&D involvement in quality assurance

At least 70% of scientists and engineers spend 10% or more of their work time doing analysis and testing of components and materials or of final products.



Technician analyzing hydraulic pump valves for wear problems produces ferrogram, then uses ferroscope, above, and colored filters to identify large wear particles shown on facing page.

IF YOU SPEND at least 10% of your work time on quality assurance (including quality control), then you are typical of the respondents to our recent survey of *R&D* readers on this subject.

To the extent that our 900-plus respondents are typical of the research and development industry, it can be said that seven out of ten scientists and engineers in R&D spend at least 10% of their time on QC or QA. Another one in ten does some QA work, but less than 10% of the time.

At the other extreme, more than one out of ten (actually one out of seven) works "nearly full time" on QA or QC.

The involvement of research and development people in quality considerations is not as surprising as it might seem at first. To begin with, in many small organizations the people in the R&D lab are the only ones on the staff who have the expertise necessary for quality analysis.

And, the instrumentation and procedures that they use in quality assurance, say 77% of our respondents who are involved in QA, are much the same as the instrumentation and procedures that they use in their research and development work.

As might be expected, there are notable differences from one discipline to the next. For example, more than 91% of the analytical chemists who responded are involved to some extent in quality assurance, while physical chemists have the lowest involvement at some 62%.

Only 5.6% of the biochemists involved in QA use

procedures that differ more than a little from those used in their R&D work. For ceramists and inorganic chemists, the figure is 30%.

And even though many of our respondents were not directly involved in quality assurance, they reported that some other person or persons in their R&D labs have such responsibilities, emphasizing again the R&D role in quality assurance.

Obviously, a person working alone cannot have a colleague in the same lab who does QA work, and just over 4% of our respondents reported working alone. None of the ceramists, physicists, or biologists reported working alone, but 7.0% of the chemical engineers and 13.0% of the biochemists say they work alone in their labs.

Instrumental chemical analysis is the single category of QC procedure most often used, but nearly half of the labs represented in our study use a combination of chemical and mechanical testing procedures.

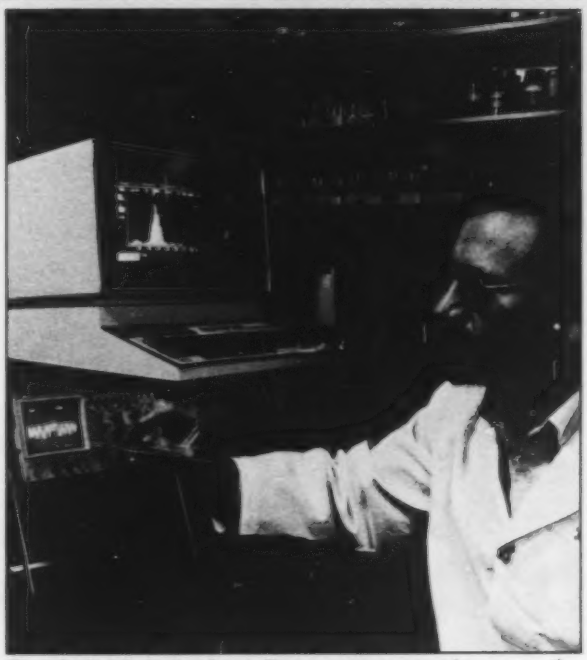
Again, predictably, the procedures of choice vary by discipline. Mechanical testing methods were used a majority of the time by 48.3% of the mechanical engineers, while electrical and electronic test methods were the choice of 68.1% of the electrical engineers.

For all but metallurgists, their own lab procedure dominated. Metallurgists in this survey use ASTM procedures 4:3 over the next highest category.

Results for all respondents follow.

1. *Do you perform quality control or quality assurance work . . .*
   - a. as part of your job assignment or job description? 49.7%
   - b. unofficially or just because it needs to be done? 32.0
   - c. not at all? 18.3
2. *If you answered a or b above, do you do it . . .*
   - a. nearly full time? 14.2%
   - b. 75% of the time? 6.5
   - c. 50% of the time? 11.3
   - d. 25% of the time? 22.7
   - e. 10% of the time? 32.9
   - f. only rarely? 12.4
3. *Do others in your lab do quality control or quality assurance work . . .*
   - a. as part of their job assignment or job description? 62.7%
   - b. unofficially or just because it needs to be done? 23.4
   - c. not at all? 9.7
   - d. I work alone 4.2
4. *Are the QC procedures in your lab primarily . . . (Note that these identify* primary *procedures.)*
   - a. chemical, wet? 6.8%
   - b. chemical, instrumental? 14.3
   - c. mechanical? 9.6
   - d. electrical/electronic? 9.7
   - e. optical? 2.0
   - f. both chemical and physical? 43.8
   - g. comparison to arbitrary standards (visual)? 5.9
   - h. other? 7.9
5. *Is the QC done in your lab related to . . .*
   - a. parts or components? 12.6%
   - b. chemical ingredients? 10.3
   - c. finished products? 21.9
   - d. other? 7.9
   - e. more than one of the above? 48.3
6. *Do your QC procedures and instrumentation differ from those used in your other laboratory activities?*
   - a. yes 23.0% b. only a little 36.2% c. no 40.8%
7. *What test procedures do you use most often?*
   - a. own lab procedures 53.0%
   - b. industry standards 16.3
   - c. ASTM standards 18.7
   - d. NBS procedures 1.4
   - e. military tests 4.0
   - f. others 6.6%

Vibration isolation system permits mechanical engineer to make precise coordinate measurements in product quality role.



Electrical and electronic quality assurance procedures were the choice of 68% of the electrical engineers who were surveyed.

R&D

NOTE

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